# PATENT SPECIFICATION

DRAWINGS ATTACHED

**849,744**

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**International Classification:—F04d.**

COMPLETE SPECIFICATION

## Improvements in Fans

We, KEITH BLACKMAN LIMITED, of Mill Mead Road, London, N.17, a British Company, and DESMOND HUMPHREY, a British Subject, of the same address, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to improvements in fans.

Fans are generally of one of two basic types, namely the centrifugal or radial flow type and the axial flow type. In the former the air is drawn into the centre or eye of the fan impeller and discharged radially into a casing or volute in which its velocity is converted into useful static pressure. In the latter type the air is drawn through the fan impeller and discharged, as the name implies, more or less in an axial direction. It will be appreciated that whilst a centrifugal fan necessitates a change in direction of inlet and outlet ducting through 90°, an axial flow fan can be installed as part of the air ducting in a straight line. Unfortunately, axial flow fans suffer from several inherent disadvantages. Firstly, when setting up relatively high pressures they tend to be noisy in comparison with a centrifugal fan performing the same duty. Secondly, when operating at their optimum efficiencies, and hence in their quietest zone of operation, the volume/pressure ratio is unsuitable for many applications. In other words, it is difficult to design an axial flow fan for a high pressure compared with low volumetric output. Thirdly, axial flow fans usually suffer from a breakdown or stall point on their characteristic curve preceding the zone of maximum efficiency and, therefore, if such a fan is used in conjunction with damper or vane control care must be taken to avoid operating the fan near the stall point. In practice this is extremely difficult.

The present invention has for its object to provide an improved construction of fan which avoids the above objections to the usual axial flow fan but retains the most important advantage of such a fan, namely straight-through flow.

The improved fan of the present invention includes a cylindrical casing having an inlet of Venturi form the throat area of which depends on the particular duty for which the fan is intended. In the widening part of the Venturi beyond the throat there is mounted for rotation within the cylindrical casing a conical hub to which are attached a plurality of blades having a compound curvature such that when the impeller is rotating they impart to the entering air stream first an axial and then a centrifugal component. A plurality of air guides vanes is placed adjacent to the fan impeller thus constituted to suppress the whirl component of flow so that the air leaves the vanes in a wholly axial direction, and these guide vanes are used to support a drum within the casing coaxial with the casing. This drum may be the housing of an electric motor driving the fan or the support for a separate shaft and bearing assembly. At the exit end of the fan a fairing is provided on the drum or housing of the driving motor such that the annular space between this fairing and the casing increases in area towards the discharge end of the fan, this space thus serving for diffusion or the regaining of static pressure.

The invention is illustrated in the accompanying drawings in which:—

Fig. 1 is a diagrammatic elevation partly in section of one form of the improved fan;

Fig. 2 is a perspective view of the conical hub and of the blades of compound curvature mounted thereon;

Fig. 3 is an elevation of the conical hub and showing one of the blades;

Fig. 4 is a developed view of the under surface of one of the blades;

Fig. 5 is a plan view, after shaping, of the upper surface of the blade shown in Fig. 4;

Fig. 6 is a view of the blade shown in Fig. 5 tilted so that its trailing edge bears on a plane surface and showing the upper surface of the blade;

Fig. 7 is an end projection of the tilted blade shown in Fig. 6 seen from the leading edge and showing the under surface of the blade;

Figs. 8, 9, 10 and 11 are sections taken on

the lines $8^x$—$8^x$, $9^x$—$9^x$ $10^x$—$10^x$, and $11^x$—$11^x$, respectively of Fig. 5.

Referring to Figs. 1, 2 and 3, 10 denotes the cylindrical casing of the fan within which is located an inlet 11 of Venturi form. Beyond the throat area 12 of the Venturi in the widening part of the Venturi there is mounted for rotation within the cylindrical casing 10 a conical hub 13 to which are attached a plurality of blades 14. These blades 14 are shown in Figs. 1 to 3 as extending beyond the conical hub 13. The blades are held rigid between the hub 13 and a surrounding conical shroud 15 lying within the widening part of the Venturi.

The blades are shown in detail in Fig. 6—11 in which 18 is the leading edge, 19 the hub edge, 20 the trailing edge and 21 the shroud edge. They have a compound curvature such that when the impeller is rotating the blades impart to the entering air stream first an axial and then a centrifugal component. The arrow A in Fig. 2 indicates the direction of rotation of the hub 13. Beyond the impeller there are mounted in the casing 10 a plurality of guide vanes 22 serving to suppress the whirl component of flow whereby the air leaves the vanes in a wholly axial direction. In the form shown these vanes are provided with flanges by which they are secured to the housing 23 of an electric motor driving the fan and to the cylindrical casing 10 and serve to hold the motor coaxially of the casing. The part 23 may however be merely a support for a separate shaft and bearing assembly for the impeller. At the discharge end of the fan a fairing 24 is provided on the part 23, thus providing an annular space within the casing 10 of dimensions expanding towards the discharge end of the fan, this space providing for diffusion or the regaining of static pressure.

It will be observed that the improved fan is externally similar to the conventional axial flow fan. It has however the characteristics of a centrifugal fan in that at the same speed the pressure developed is approximately twice that developed by a conventional single stage axial flow fan, yet with a lower noise level.

WHAT WE CLAIM IS:—

1. A fan comprising a tubular casing having an air inlet at one end with a Venturi form of passage and with an air discharge outlet at the other end, an impeller comprising a conical hub and a plurality of blades located in the expanding portion of the Venturi beyond the throat thereof, the blades having a compound curvature whereby to impart to the air first an axial component and then a centrifugal component and a plurality of guide vanes disposed within the casing beyond the impeller and serving to suppress the whirl component of flow whereby the air leaves the vanes in a wholly axial direction.

2. A fan as claimed in claim 1 in which the blades of the impeller occupy the expanding area of the Venturi beyond the throat and the guide vanes are mounted on the inner wall of the tubular casing.

3. A fan as claimed in claim 1 or 2 in which the central portion of the casing beyond the impeller is occupied by a drum or cylinder coaxial with the axis of the impeller and the guide blades extend between the inner wall of the casing and the drum or cylinder.

4. A fan as claimed in any of the preceding claims in which the drum or cylinder is constituted by the housing of an electric motor driving the impeller.

5. A fan as claimed in claim 3 and 4 in which the drum or cylinder is provided towards the discharge end of the casing with a fairing to provide an area free from interruption which increases in dimensions towards the discharge end of the casing.

6. A fan as claimed in claim 3 in which the drum or cylinder serves as a support for a separate shaft and bearing assembly for the impeller.

7. In a fan as claimed in claim 1 an impeller having blades of compound curvature substantially as described and as illustrated in the accompanying drawings.

8. A fan constructed and arranged substantially as described with reference to Figs. 1 to 3 of the accompanying drawings.

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Agents for the Applicants.

## PROVISIONAL SPECIFICATION

# Improvements in Fans

We, KEITH BLACKMAN LIMITED, of Mill Mead Road, London, N.W.17, a British Company, and DESMOND HUMPHREY, a British subject of the same address, do hereby declare this invention to be described in the following statement:—

The subject of the present invention is an improved fan in which the physical advantage of an axial flow fan is retained, i.e. straight through flow, but which overcomes the objections to the axial flow type with respect to noise level and aerodynamic characteristics.

Fans are generally speaking considered to be one of two basic types, namely the centrifugal or radial flow type and the axial flow type. In the former the air is drawn into the centre or eye of the fan impeller and discharged radially into a casing or volute in which its velocity is converted into useful static pressure. With the latter the air is drawn through the fan impeller and discharged, as the name implies, more or less in an axial direction. It will be appreciated that whilst a centrifugal fan necessitates a change in direction of inlet and outlet ducting

through 90°, an axial fan can be installed as part of the air ducting in a straight line. Unfortunately, axial flow fans suffer from several inherent disadvantages. Firstly, when setting up relatively high pressures they tend to be noisy when compared with a centrifugal fan performing the same duty. Secondly, when operating at their optimum efficiencies, and hence in their quietest zone of operation, the volume/pressure ratio is unsuitable for many applications. In other words, it is difficult to design an axial fan for a high pressure compared with low volumetric output. Thirdly, axial flow fans usually suffer from a breakdown or stall point on their characteristic curve preceding the zone of maximum efficiency and, therefore, if such a fan is used with damper or vane control care must be taken to avoid operating the fan near the stall point. In practice this is extremely difficult. The fan forming the subject of the present invention overcomes the objections to axial fans outlined above, tbut retains the most important advantage of them, namely straight-through flow.

In accordance with the invention there is mounted within a cylindrical casing an inlet substantially in the form of a Venturi having a throat area which depends on the particular duty for which the fan is intended. Beyond the throat in the widening part of the Venturi is mounted for rotation with the cylindrical casing a substantially conical hub to which are attached a plurality of blades having a compound curvature such that then the impeller is rotating they impart to the entering air stream first an axial and then a centrifugal component. A plurality of air guide vanes is placed adjacent to the fan impeller to convert the flow into axial flow and these guide vanes are used to support a centre drum. Alternatively, this drum could be the fan driving motor or support for a separate shaft and bearing assembly. At the exit end of the fan a fairing is attached to the centre drum or driving motor such that the annular space between this fairing and the outer casing expands in area towards the discharge end of the fan and thus this space is used for diffusion or static pressure regain.

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Agents for the Applicants.

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849,744 COMPLETE SPECIFICATION
3 SHEETS

*This drawing is a reproduction of the Original on a reduced scale.*
*SHEET 1*

FIG. 1.

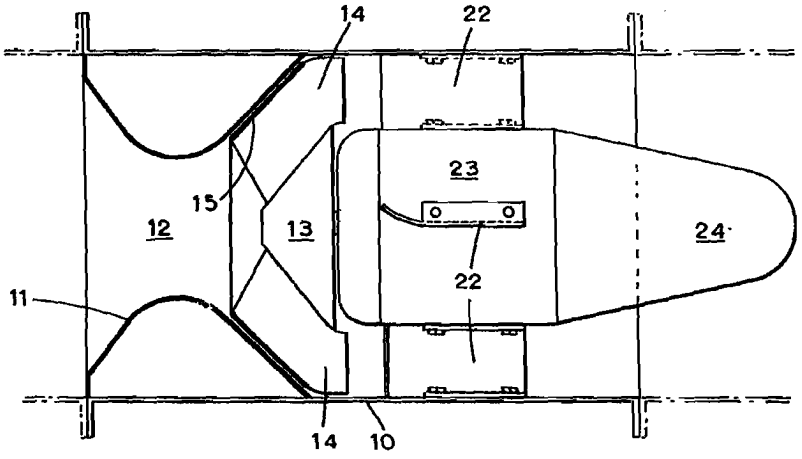



FIG. 2.

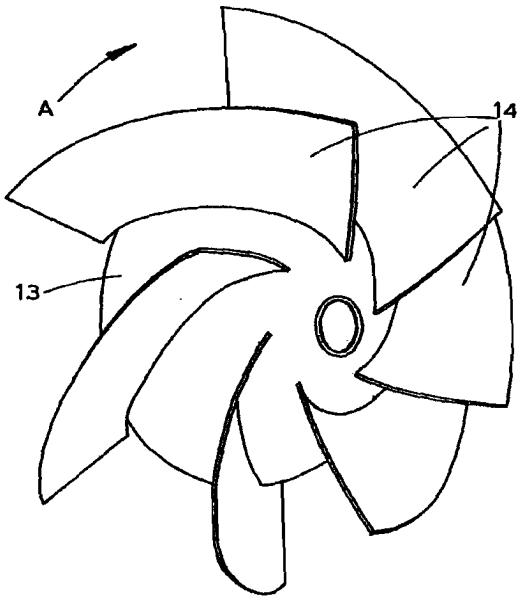
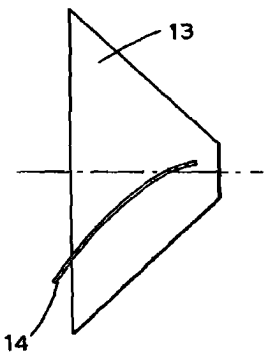



FIG. 3.



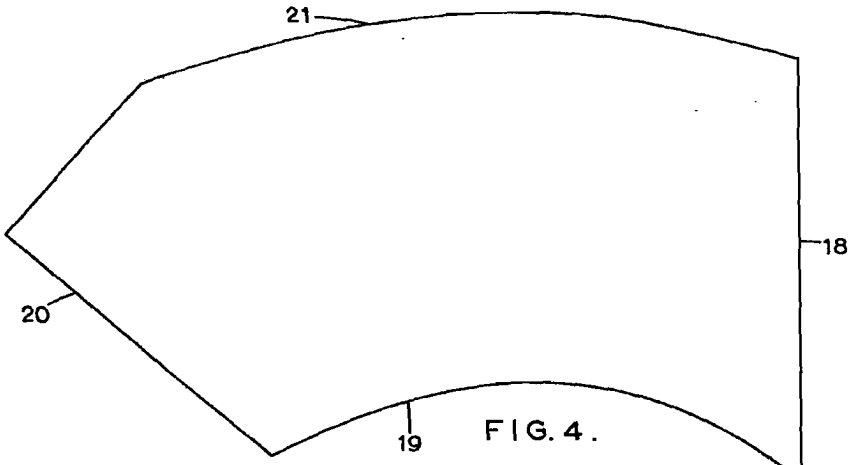



FIG. 4.

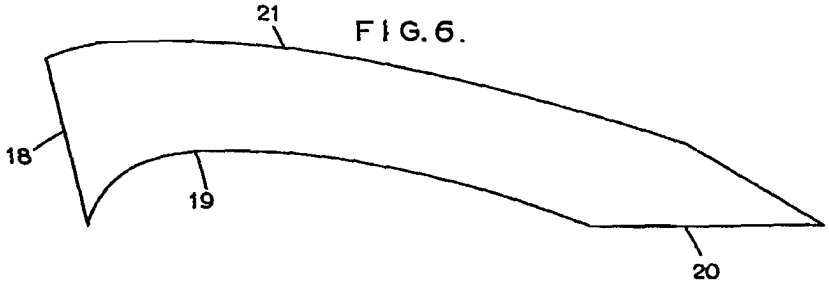
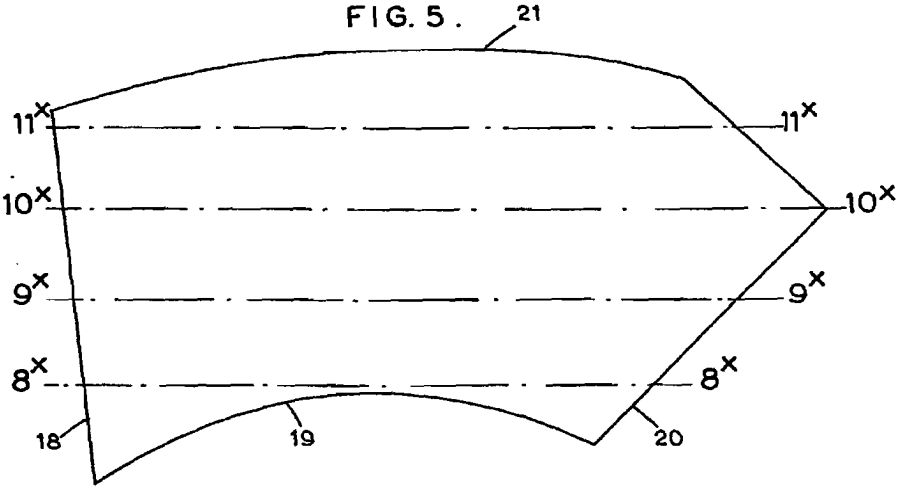



FIG. 6.

FIG. 5.



849,744 COMPLETE SPECIFICATION
3 SHEETS

This drawing is a reproduction of the Original on a reduced scale.
SHEETS 2 & 3

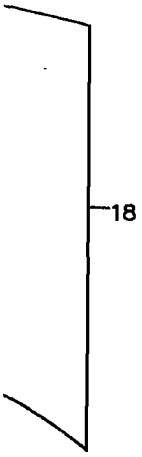



FIG. 7.

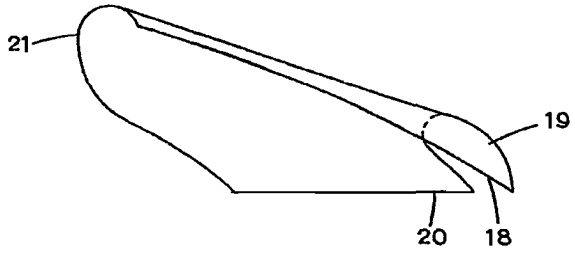



FIG. 8.

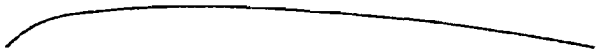


FIG. 9.

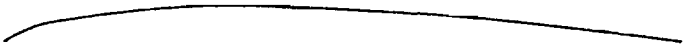
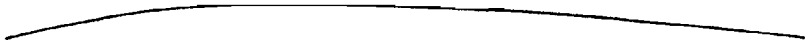


FIG. 10.



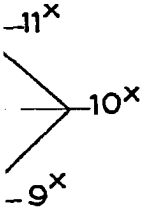



FIG. 11.

849,744 COMPLETE SPECIFICATION
3 SHEETS

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SHEETS 2 & 3

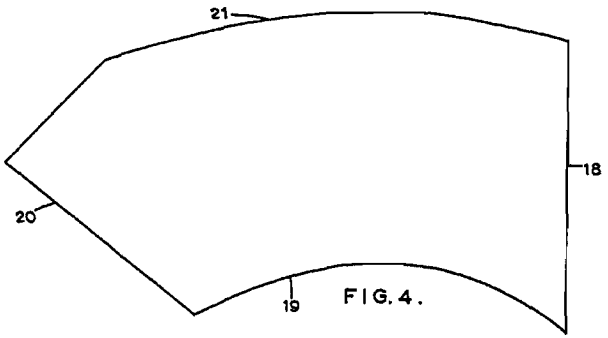


FIG. 4.

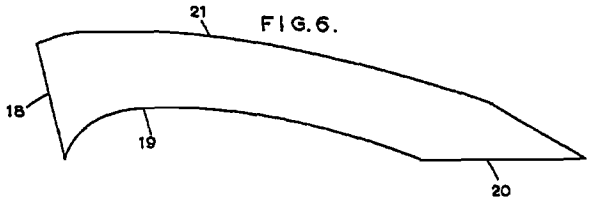


FIG. 6.

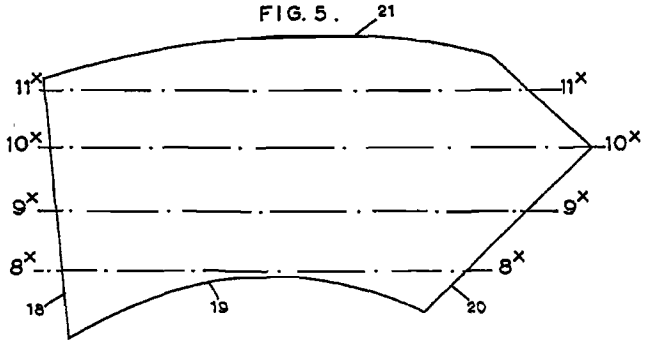


FIG. 5.

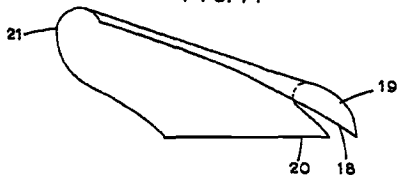


FIG. 7.

FIG. 8.

FIG. 9.

FIG. 10.

FIG. 11.